CELF Audio Video Graphics Specification v2

San Jose, USA, Tuesday April, 11th 2006

Ruud Derwig – AVGWG chair

Outline

- Introduction
- Requirements
- Technologies and solutions
- Specification
  - Audio
  - Video
  - Graphics
- Status & Next steps
- Summary
- Acknowledgements & References

Specification Objectives

- Reduce fragmentation, provide direction

- Optimized for CE devices

- Support a wide range of products

- Respect CE value chains and business models, enable differentiation and innovation

LinuxWorld: Motorola reports on its experiences with Linux phones
Wednesday April 05, 2006 (06:13 PM GMT)

*... Motorola believes that for embedded Linux to grow in mobile phone devices, it must evolve as **a platform that multiple handset manufacturers, application vendors, and phone service carriers all build together**.*

*This level of **standardization is necessary** to foster innovation and accelerate development, he says. ... **unifying the lower levels** of the platform will help them get their phones to market, but still leave room for them to differentiate their products from one another.*

(http://www.mobile.newsforge.com/article.pl?sid=06/04/05/1815218)

CE Linux Forum

Process

- Specification prepared by the CELF Audio Video Graphics Working Group
  - Requirements
  - Technologies & solutions
  - Specification writing, review and rework cycles
  - Working group approval
- Published for review
  - CELF members
  - Public Wiki
- CELF Architecture group review and voting
- CELF Board of Directors voting

Requirements - 1/2

- Global
  - Support wide range of products: Home, Mobile, and Automotive
  - Low-level, platform API
  - Abstract from implementation, enable middleware portability
  - Scalable, deal with diversity of the CE domain
  - Well documented, consistent syntax, semantics, behavior
  - Enable evolution, no unnecessary coupling between interfaces
  - Open API, available without cost, no implementation restrictions

- Linux related
  - Fit with Linux and existing solutions from AVG specification v1.0
  - Allow for efficient implementation on Linux

Requirements - 2/2

- Domain scope related
  - CELF Mobile Phone Profile working group
    - Limited input for this version
  - CELF Digital TV/STB Profile working group
    - Focus of this version
  - Analog and digital broadcast (NTSC, PAL, ATSC, DVB, ISDB, ...)
  - Personal Video Recorders (PVR), Digital Media Adaptors (DMA)
  - Decoding and rendering of formats like wav, midi, jpeg,mpeg, …
  - Multiple graphics/video planes, alpha blending, …
  - Simple data services and interactivity (closed caption, teletext, MHEG, MHP, OCAP)
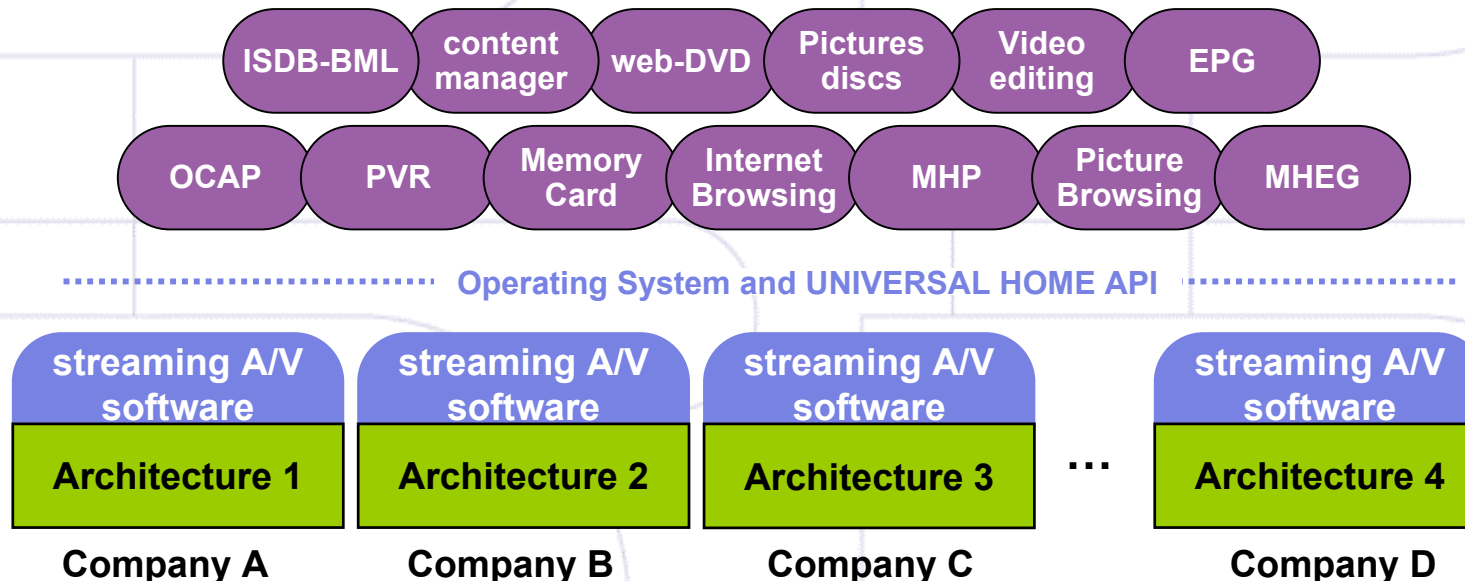
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Universal Home API

- Defined by the UHAPI Forum

- Simplifying software development for CE products

- Application portability over multiple HW/SW platforms

- Open Source implementation: UHAPI4Linux

| ISDB-BML | content manager | web-DVD | Pictures discs | Video editing | EPG |

| OCAP | PVR | Memory Card | Internet Browsing | MHP | Picture Browsing | MHEG |

.... Operating System and UNIVERSAL HOME API ....

streaming A/V software	streaming A/V software	streaming A/V software		streaming A/V software
Architecture 1	Architecture 2	Architecture 3	...	Architecture 4
Company A	**Company B**	**Company C**		**Company D**

UHAPI 1.1 contents

General documents (11) :
API Specification Reader's Guide
API Naming Conventions
Error Handling
Execution Architecture
Notification
Qualifiers Quick Reference
API Evolution Rules
Get / Set Specification Patterns
Handling variation
Accessing UHAPI's functionality and third-party binding
Handling Disturbed Signals

API specifications (54) :
Front End Components (12)
Analog Audio & Video Demodulation
Analog AV Input
Anti Aging
Analog Audio Decoding
Channel Decoding
RF Amplification
Out Of Band Tuning & Demodulation
Signal Strength
Tuning
HdmiIn
SPDIF-in
VBI Slicing

Decoders/Encoders (7)
ATSC Decoder
Image Decoding
SPDIF Decoding
STC Decoding
Transport Stream Demultiplexing
Transport Stream Multiplexing
SPTS Transmuxing

Video Processing Components (15)
Ambient Level
Analog Video Decoding
Analog Video Encoding
Analog Video Encryption
Basic Video Featuring
Black Bar Detection
Color Transient Improvement
Dynamic Noise Reduction
Histogram Modification
Noise Measurement
Scan Rate Conversion
Sharpness Enhancement
Sharpness Measurement
Video Color Enhancement
Video Mixing

Audio Processing Components (10)
Audio Automatic Volume Leveling
Audio Bass Enhancements
Audio Dynamic Range Control
Audio Mixing
Audio Noise Generation
Audio Program Selection
Audio Volume Control
Equalizing
Speaker Set /Headphones
Output Configuration

Generic/other (10)
Analog AV Output
SPDIF-out
Data Injecting
Data Extracting
Connection Management
Fatal Error Handling
I am Alive
Pin Objects
Unknown
URL Source

Type specifications (2) :
Basic Types
Global Types

DirectFB

- Open Source project (directfb.org)

- Powerful graphics library for Linux

- Designed with embedded systems in mind

- Compliant to Multimedia Home Platform (MHP)

- Provides HW abstraction

- Allows HW acceleration where possible

- Recommended by the CELF 1.0 specification, adopted by many members

Features

- Drawing (lines, rectangles, filling etc.)
- Blitting (scaled blended, color keyed etc.)
- Font rendering
- Window management
- Multiple application support
  - resource management
- Handling input events
- Scaling
- Color keying
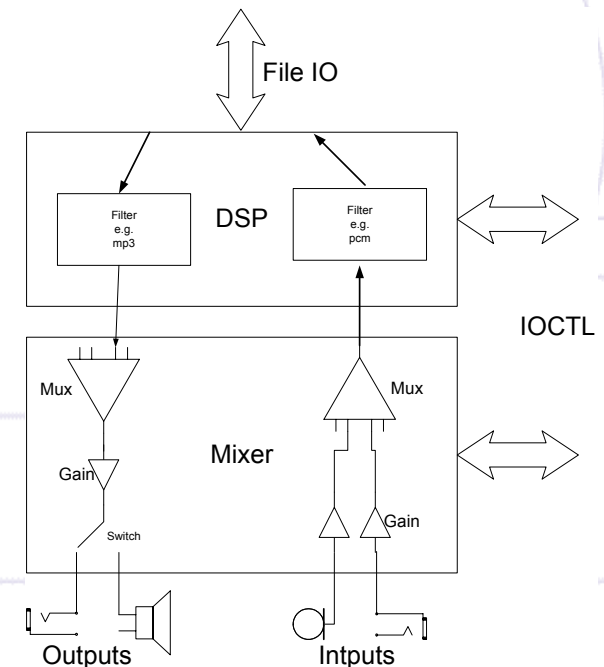- Layer mixing
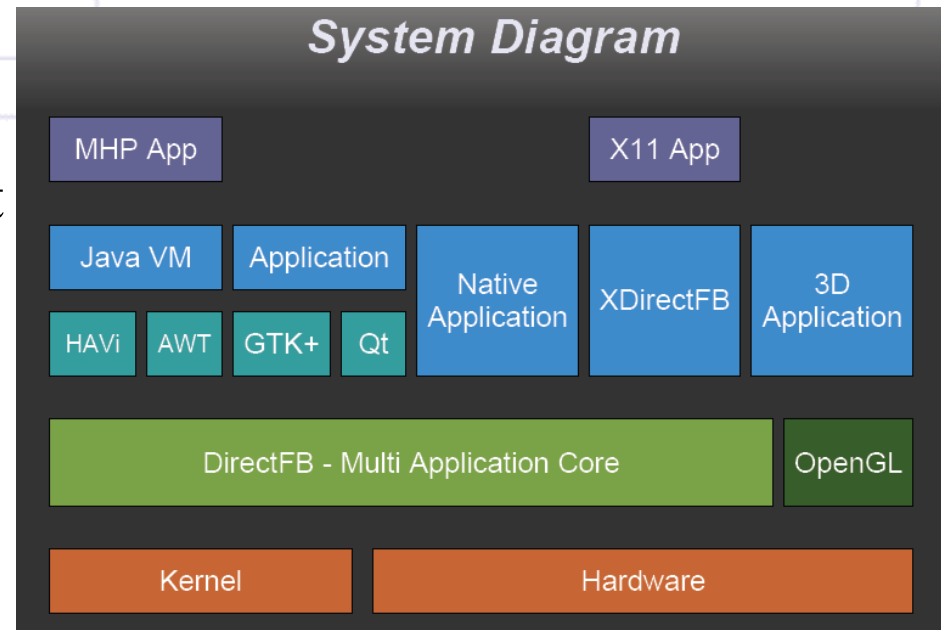
OpenGL ES

- Defined by the Khronos group
- Small-footprint subset of OpenGL
- Powerful, low-level API with full functionality for 3D games
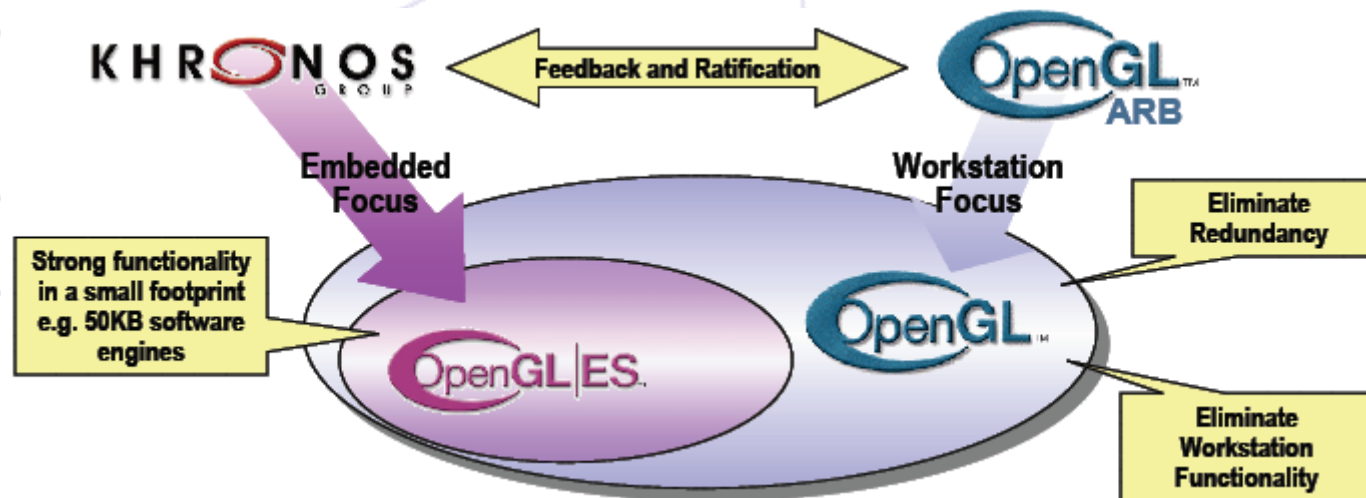
ALSA

- Open Source project (alsa-project.org)
- Advanced Linux Sound Architecture
  – audio and MIDI functionality
- Efficient support for all types of audio interfaces
  – consumer soundcards to professional multichannel audio
- Fully modularized sound drivers
- SMP and thread-safe design
- User space library (alsa-lib) to simplify application programming and provide higher level functionality

File IO

Filter
e.g.
mp3

DSP

Filter
e.g.
pcm

IOCTL

Mux

Mux

Mixer

Gain

Gain

Switch

Outputs

Intputs

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Compliance Classifiers

- Conventions from IETF RFC 2119
  - [M]ust, Required, Shall
  - [S]hould, Recommended
  - [O]ptional, May
  - E[X]pressly Forbidden

- AVG Specification v2.0
  - In good Linux/Open Source tradition: toolbox approach
 - Providing direction by recommendation[S], not [M]andating

Audio – 1/2

- Rational
  - UHAPI has broadest CE domain coverage
  - ALSA(OSS) has best coverage of "PC-domain" (midi, professional)
  - Scalable, extendible, well documented
  - Functional interfaces, implementation independent
- Specification

  [S] Broadcast audio decoding functions: UHAPI
  - Analog Audio Decoding, SPDIF-in, ATSC Decoder, SPDIF-out, SPDIF Decoding

  [S] Audio processing and rendering functions: UHAPI
  - Automatic Volume Levelling, Program Selection, Bass Enhancement, Volume Control, Dynamic Range Control, Equalizing, Mixing, Output Configuration, Noise Generation, Speaker /Headphones

  [S] PC (sound cards) domain functionality: ALSA
  - Synthesizing, MIDI interfaces

  [O] Other domains: existing ALSA and UHAPI interfaces may be used

  [O] Implementations of the UHAPI audio interfaces may internally use ALSA or OSS or other – dedicated – implementations.

Audio – 2/2
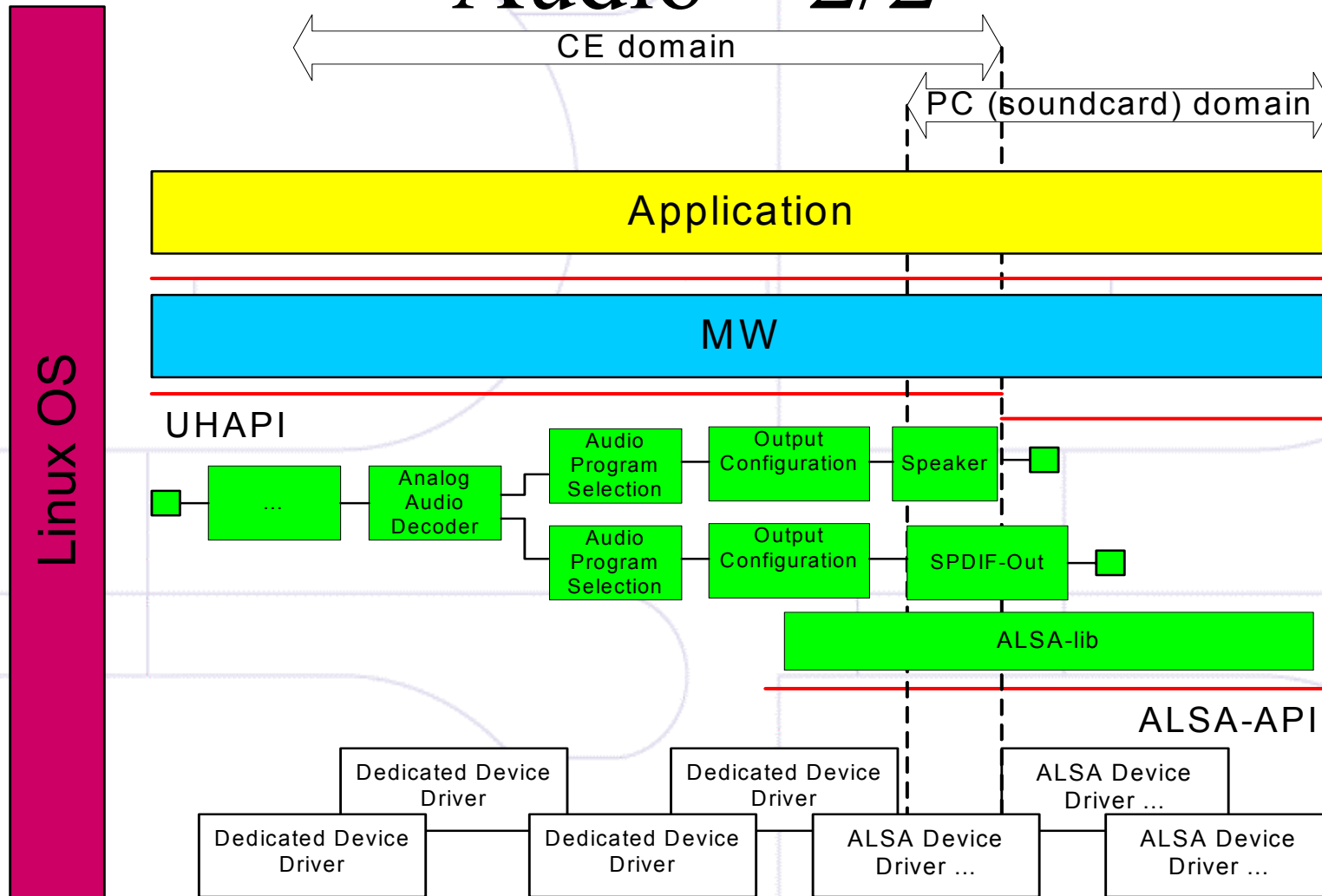
Video – 1/3

- Rational

  – UHAPI has broadest coverage for analog and digital broadcast, and PVR

  – UHAPI interface matches well with existing Linux solutions (V4L, LinuxDVB)

  – Video & graphics Mixing: Combine DirectFB and UHAPI

  – Scalable, extendible, well documented

  – Functional interfaces, implementation independent

- Specification

  [S] Broadcast video decoding functions: UHAPI Forum

  - Analog Audio & Video Demodulation, RF Amplification, Analog Video Decoding, Signal Strength, ATSC Decoder, STC Decoder, Analog AV Input, Transport Stream Demultiplexing, Analog AV Output, Transport Stream Multiplexing, Channel Decoding, Tuning, HdmiIn, URL Source, Image Decoding 2, VBI Slicing, Out Of Band Tuning & Demodulation

Video – 2/3

- Specification

  [S] Video processing and rendering functions: UHAPI

  - Ambient Level, Histogram Modification, Analog Video Encoder, Noise Measurement, Analog Video, Encryption, Scan Rate Conversion 2, Anti Aging, Sharpness Enhancement, Black Bar Detection, Sharpness Measurement, Video Color Enhancement, Basic Video Featuring, Color Transient Improvement, Video Mixing, Dynamic Noise Reduction

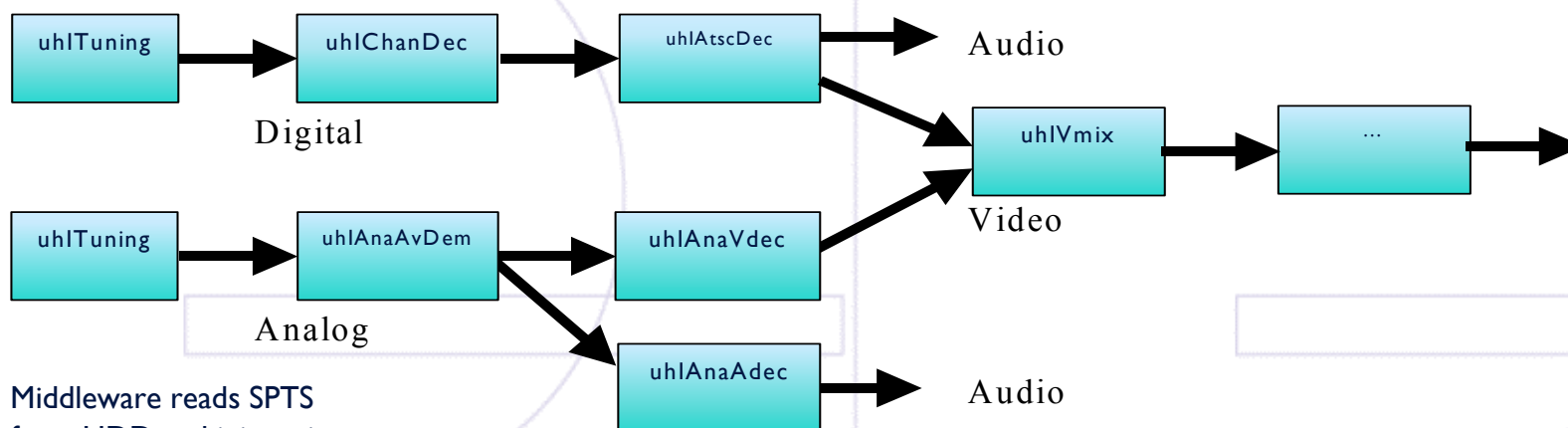 [S] PVR video functions: UHAPI Forum

  - Data Injecting, SPTS Transmuxing, Data Extracting

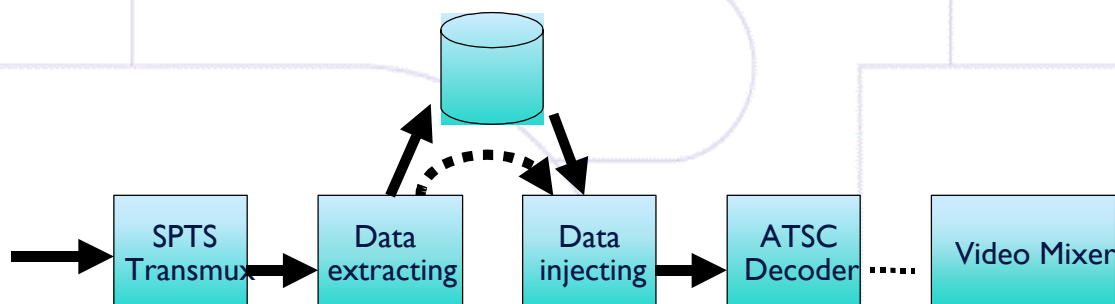 [O] Other domains: Existing UHAPI interfaces may be used

  [O] Implementations of the UHAPI interfaces may use existing V4L(2) or LinuxDVB implementations

Video – 3/3

```
uhITuning → uhIChanDec → uhIAtscDec → Audio
            Digital

uhITuning → uhIAnaAvDem → uhIAnaVdec
            Analog              → uhIVmix → ... →
                                    Video
                    → uhIAnaAdec → Audio
```

Middleware reads SPTS
from HDD and injects it

```
Injector          SPTS     TsDmx | Video | Audio    Decoded content
Data injecting            decoder decoder           → Video Mixer →
                          ATSC Decoder (simplified)
```

```
→ SPTS      → Data      → Data      → ATSC     ····· Video Mixer
  Transmux    extracting   injecting   Decoder
```
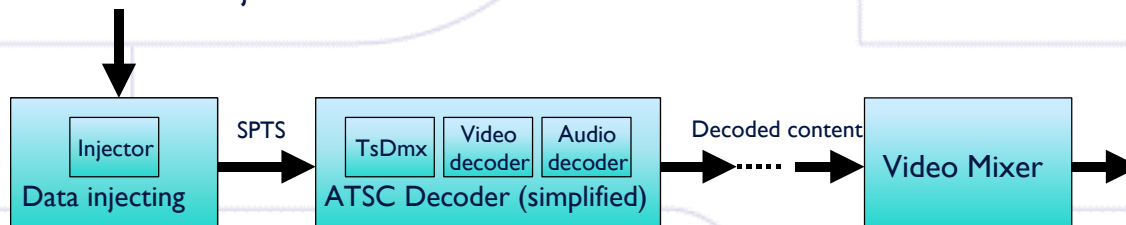
Graphics - 1/2

- Rational
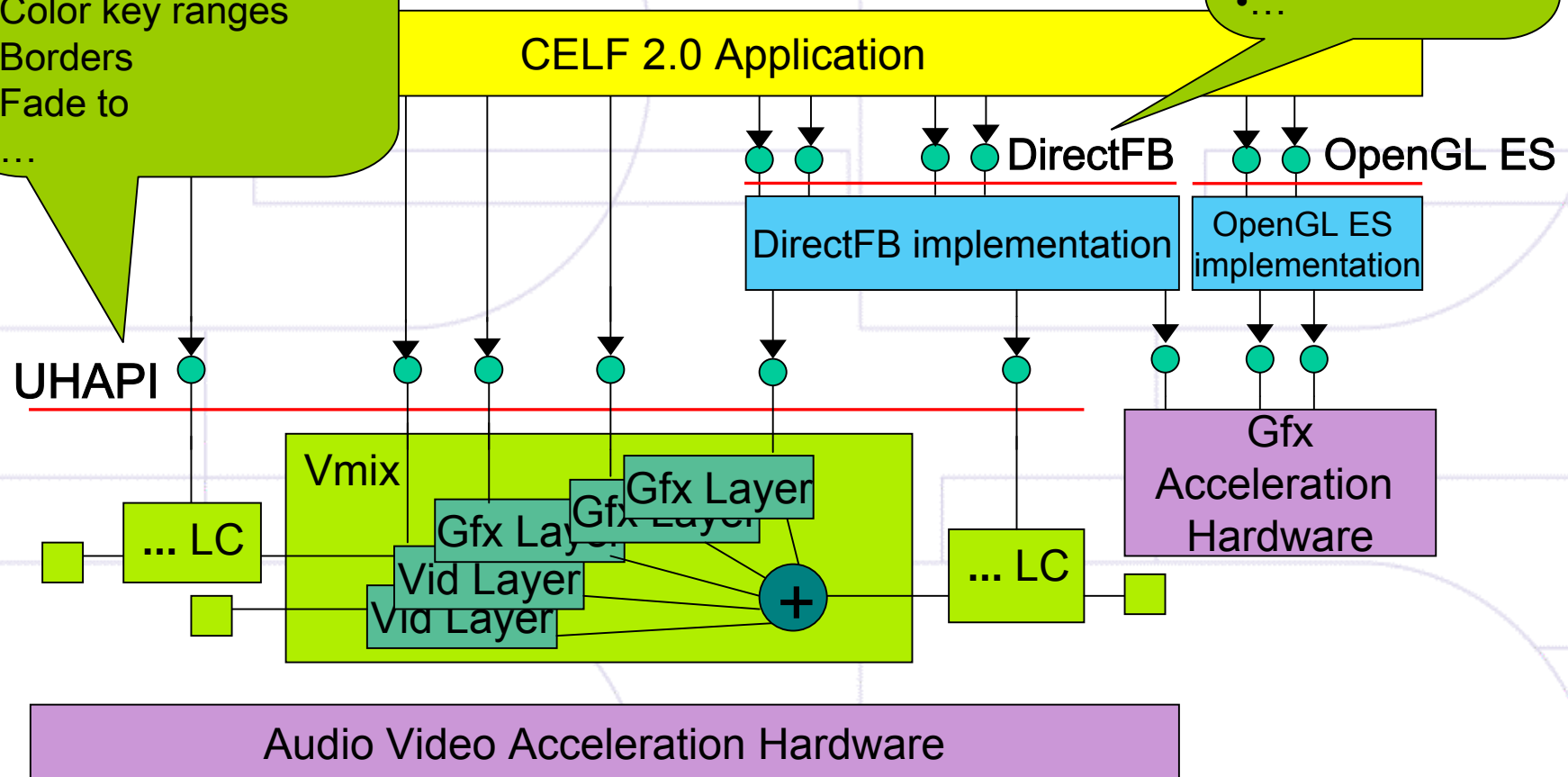 - Widespread use of both DirectFB and standard FrameBuffer
  - UHAPI Video Mixing has most features for composition and scaling
  - OpenGL ES is the de-facto industry standard in the mobile domain and applicable in the home domain
  - Scalable, extendible, well documented
  - Functional interfaces, implementation independent

- Specification
  - [S] The standard Framebuffer is recommended for use in CE devices
  - [S] DirectFB is recommended for use in CE devices
    - [M] IDirectFB, IDirectFBSurface, IDirectFBFont, IDirectFBDisplayLayer, Window, Palette
    - [O] IDirectFBImageProvider, IDirectFBVideoProvider, IDirectFBDataBuffer
    - [X] IDirectFBScreen
  - [S] Graphics combined with video: DirectFB (graphics) combined with UHAPI (video mixing)
  - [S] 3D graphics: OpenGL ES

Graphics – 2/2

•Accelerated gfx
•Windowing
•Input devices
•Fonts
•…

•Non-linear scaling
•Render Subtitles
•Color key ranges
•Borders
•Fade to
•…

CELF 2.0 Application

DirectFB

OpenGL ES

DirectFB implementation

OpenGL ES implementation

UHAPI

Vmix

Gfx Layer

Gfx Layer

Gfx Layer

Vid Layer

Vid Layer

+

... LC

... LC

Gfx Acceleration Hardware

Audio Video Acceleration Hardware

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Status

- CELF AVG working group has finished and approved the specification
- Thursday, April 13th CELF Architecture Group voting
- Formal Board of Directors approval: tbd.

- Open Source implementations available
    - DirectFB
    - ALSA
    - UHAPI interfaces
    - No fully integrated version of DirectFB, UHAPI, ALSA, OpenGL ES
- "Commercial" (partial) implementations available, too
    - Offers from various (semiconductor) vendors

What's Next

- Stimulate (Open Source) full implementations
  - OpenGL ES and DirectFB
  - UHAPI4Linux on standard PC
    - Add DirectFB
    - … and ALSA, OpenGL ES
  - Members on specific boards
- Extend Specification
  - Media Processing Framework
    - Gstreamer, OpenMAX IL
    - …
  - Mobile domain
    - CELF Mobile Phone Profile WG
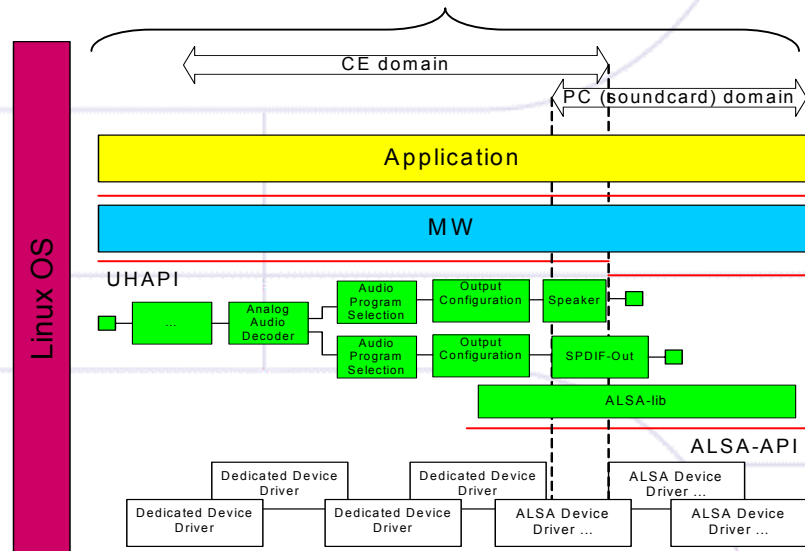   - OpenMAX
    - …

Specification Summary

Public, recommended

ALSA + UHAPI + DirectFB + OpenGL ES

Private, optional
implementation

… , OSS, V4L(2), LinuxDVB, Framebuffer, …

Audio

Video + graphics

CE domain

PC (soundcard) domain

Linux OS

Application

MW

UHAPI

Analog Audio Decoder

Audio Program Selection

Output Configuration

Speaker

Audio Program Selection

Output Configuration

SPDIF-Out

ALSA-lib

ALSA-API

Dedicated Device Driver

Dedicated Device Driver

ALSA Device Driver …

Dedicated Device Driver

Dedicated Device Driver

ALSA Device Driver …

ALSA Device Driver …

CELF 2.0 Application

DirectFB

OpenGL

DirectFB implementation

OpenGL ES implementation

UHAPI

Vmix

... LC

Gfx Layer

Gfx Layer

Gfx Layer

Vid Layer

Vid Layer

+

... LC

Gfx Acceleration Hardware

Audio Video Acceleration Hardware

Thank You!

- AVG working group members, especially
  - Aplix
  - "DirectFB.org"
  - Intel
  - Mitsubishi
  - Motorola
  - Nexwave Solutions
  - Nokia
  - NVIDIA
  - Philips
  - Samsung
  - ST

- References
  - CELF AVG Specification v2.0: http://tree.celinuxforum.org/pubwiki/moin.cgi/AudioVideoGraphicsSpec_5fV2
  - UHAPI: www.uhapi.org
    - UHAPI v1.1 version, donated by the UHAPI Forum: http://tree.celinuxforum.org/pubwiki/moin.cgi/UHAPI
    - UHAPI4Linux open source implementation: http://sourceforge.net/projects/uhapi4linux/
    - UHAPI Technical white paper: http://www.uhapi.org/technology/white_papers/uhapitechpaper-v4.1.pdf
  - DirectFB: www.directfb.org
    - DirectFB and UHAPI combination: http://tree.celinuxforum.org/CelfPubWiki/AvgUhapiApiTaskForce
  - OpenGL ES: http://www.khronos.org/opengles/spec/
  - ALSA: http://www.alsa-project.org
    - Comparison of Linux Audio interfaces: http://tree.celinuxforum.org/CelfPubWiki/AvgAudioAPIs